Lecture 7: Image Sources, Convolution, Scene Graphs

COMPSCI/MATH 290-04

Chris Tralie, Duke University

2/4/2016

Announcements

- Mini Assignment 2 Due Next Monday 11:55 PM
- Group Assignment 1 will be released before Monday
- Find partners!

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3D Rotations: Coordinate Frame Interpretation

3D Rotations: Euler Angles Visualization

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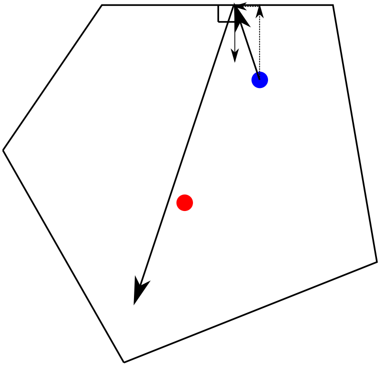
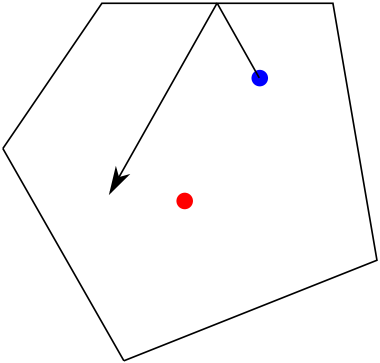
Ray Casting for Specular Reflections

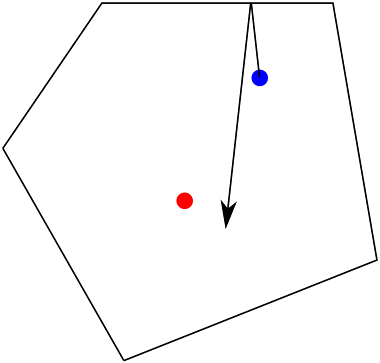


- Project onto normal, flip normal component, preserve parallel component

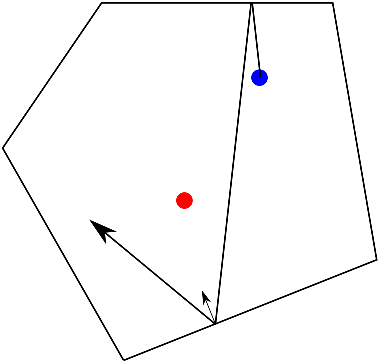
Ray Casting for Specular Reflections



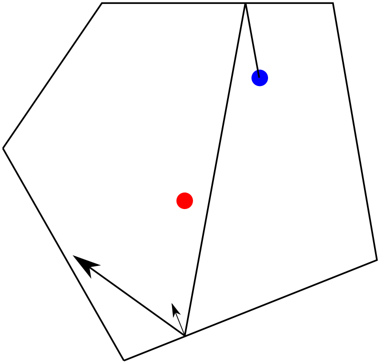
Ray Casting for Specular Reflections



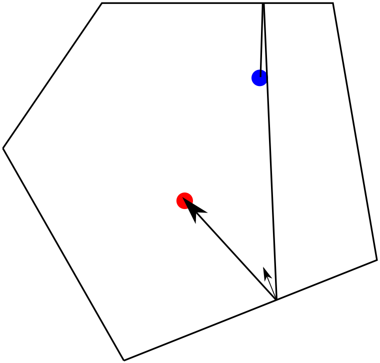
Ray Casting for Specular Reflections



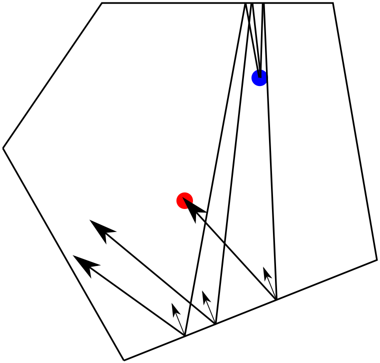
Ray Casting for Specular Reflections



Ray Casting for Specular Reflections



Ray Casting for Specular Reflections



- ▷ Dilution of precision
- ▷ Need fine angle resolution to capture!

Image Sources

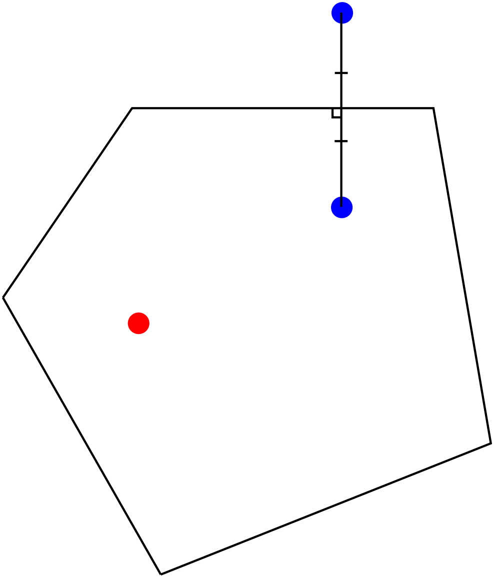


Image Sources

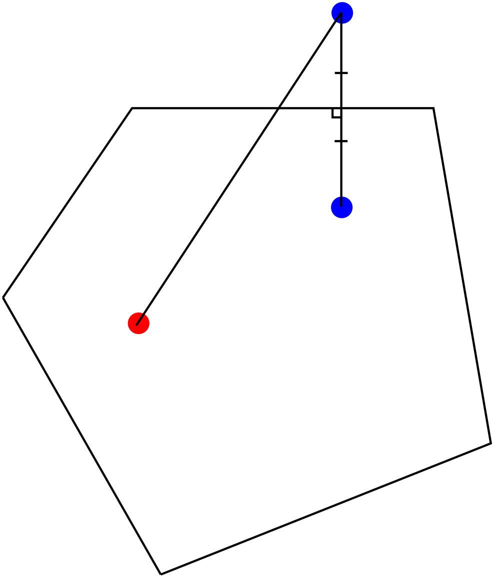


Image Sources

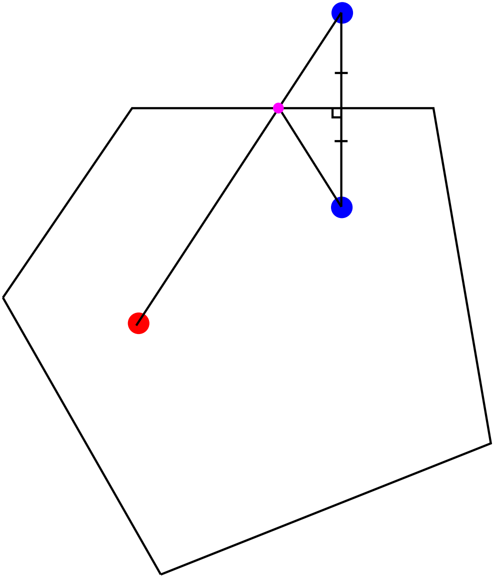


Image Sources: Proof

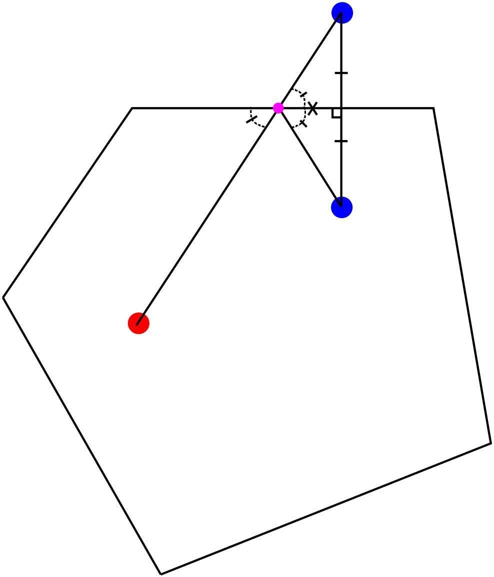


Image Sources: More Examples

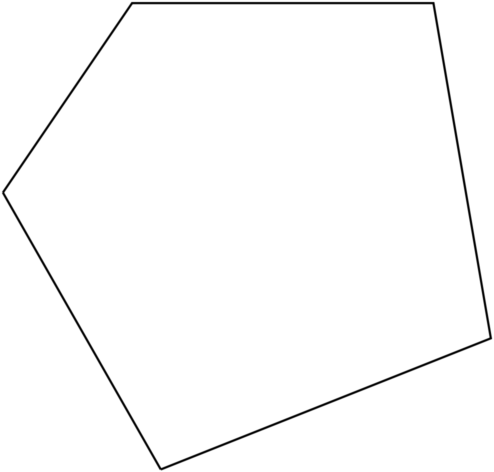
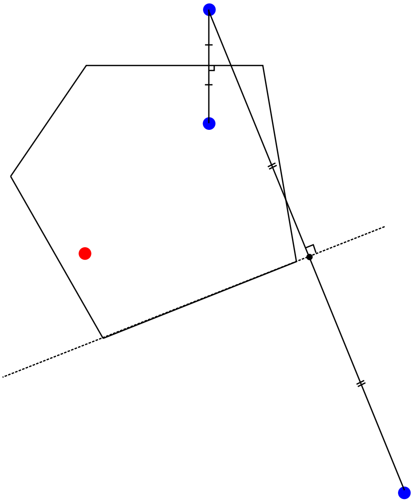


Image Sources: Second Order



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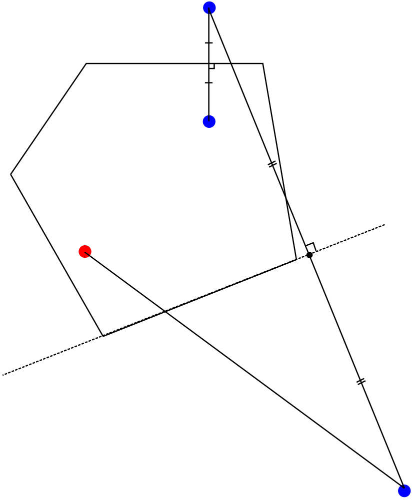

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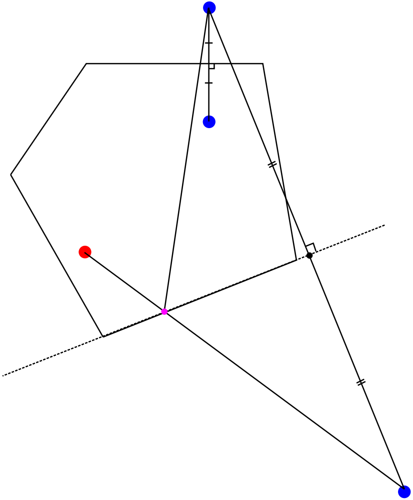


Image Sources: Second Order

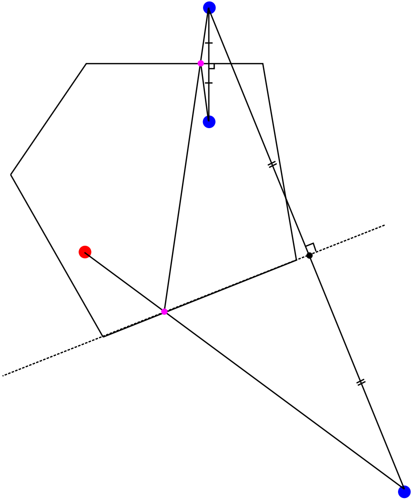
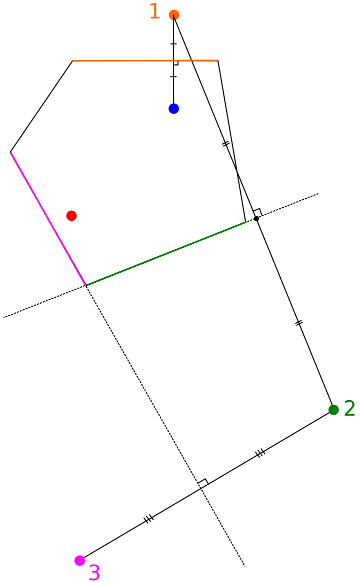


Image Sources: Third Order (!)



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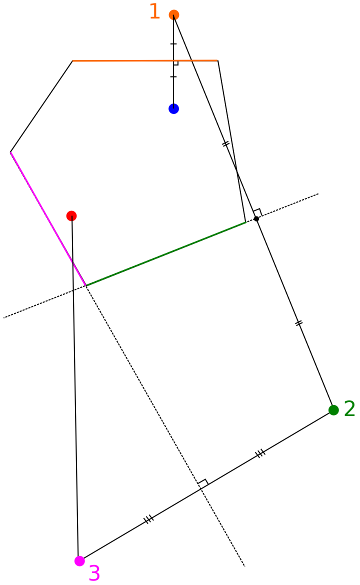
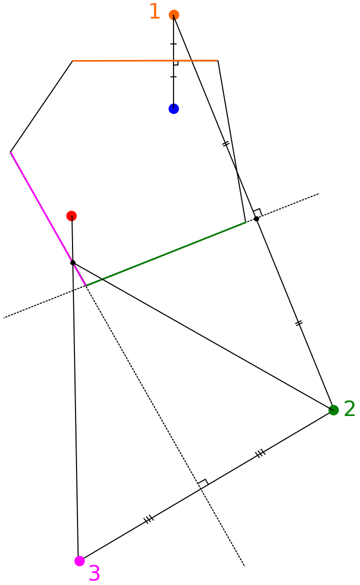


Image Sources: Third Order



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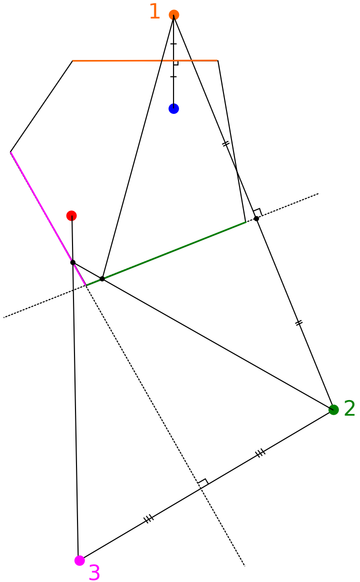


Image Sources: Third Order

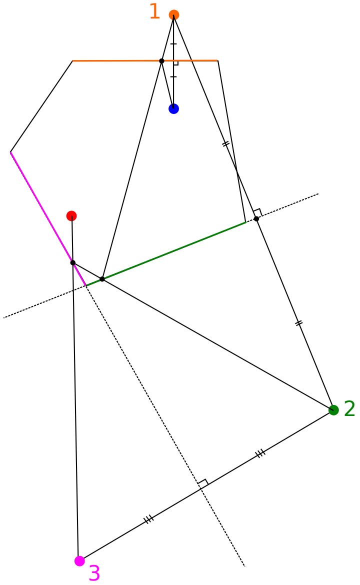


Image Sources: Third Order

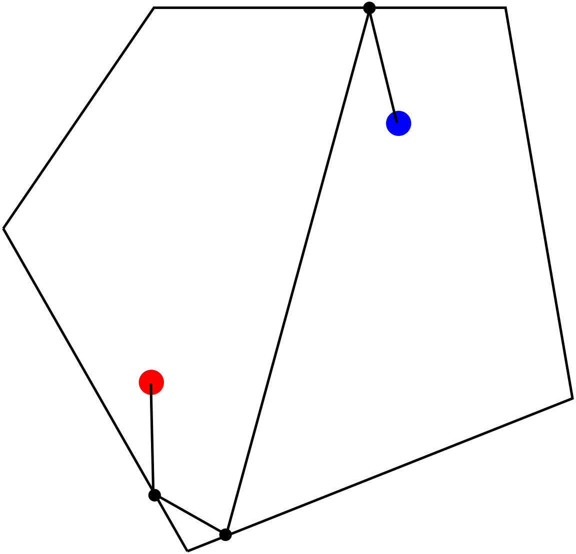


Image Sources: Occlusions

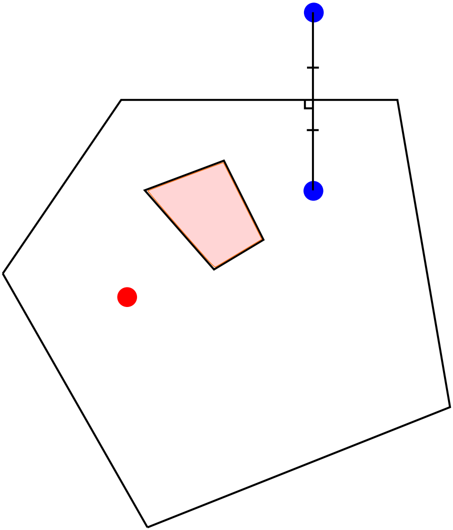


Image Sources: Occlusions

Ray needs to hit target before anything else

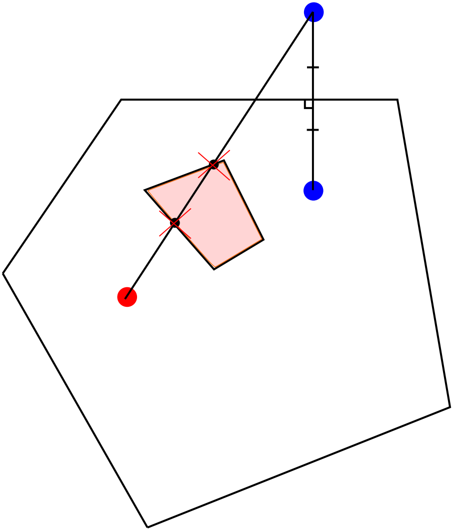


Image Sources: Point Containment

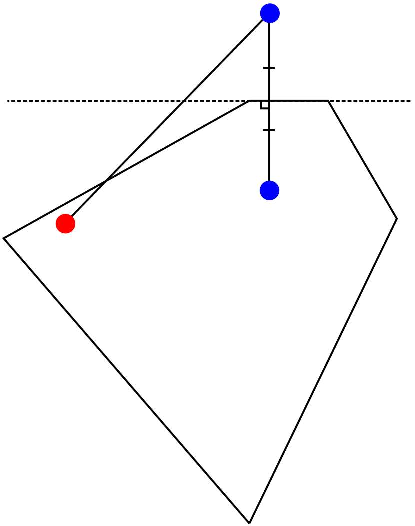
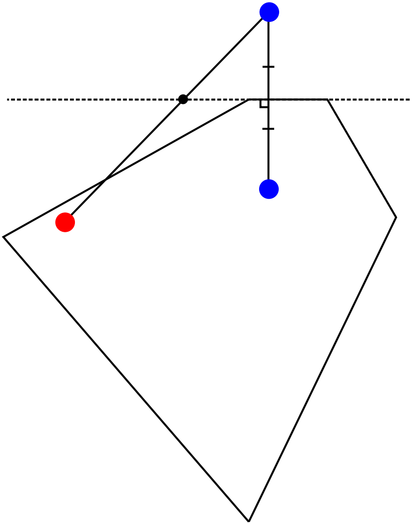


Image Sources: Point Containment

Intersection with line (plane in 3D) must be in interior of polygon



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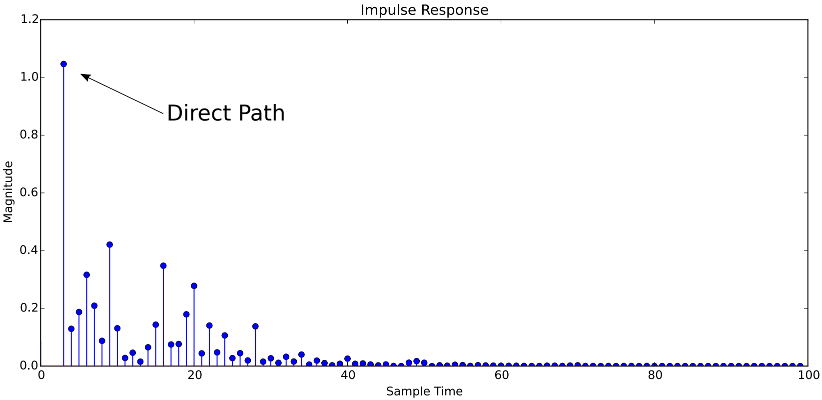
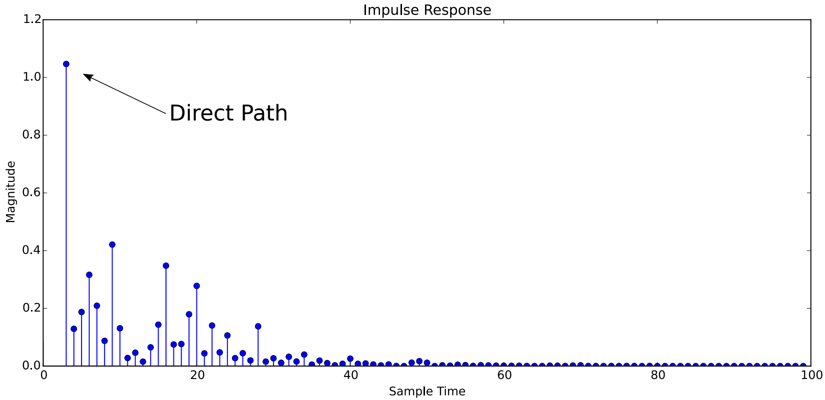
Impulse Response

- Convert lengths of all paths into times, amplitude records decay



Impulse Response

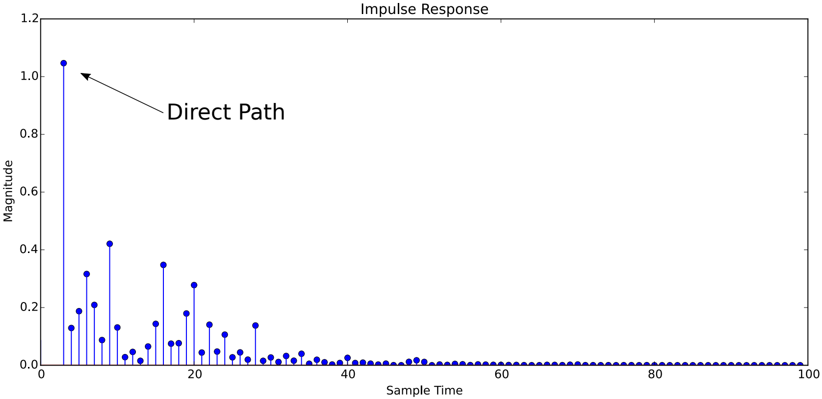
- ▷ Convert lengths of all paths into times, amplitude records decay



- ▷ What causes decay?

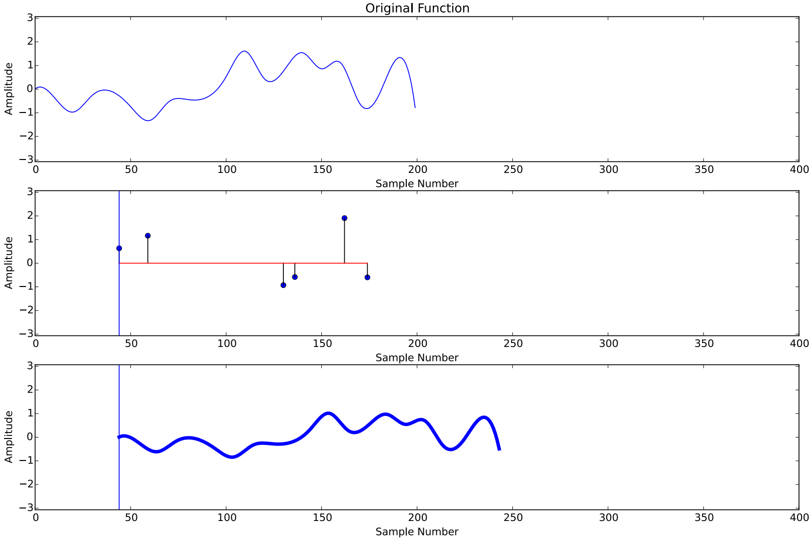
Convolution

- ▷ Convolution: What do sounds sound like in this environment?



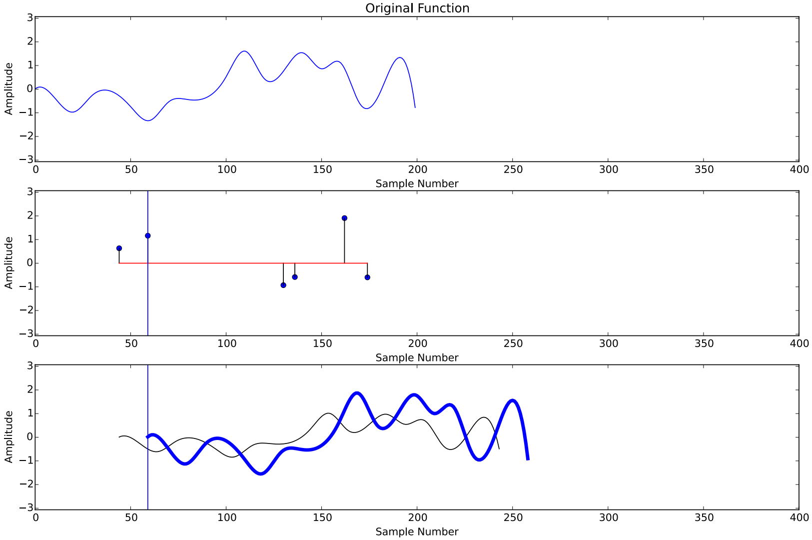
Convolution

- Add overlapping signals, *delayed* and *decayed*



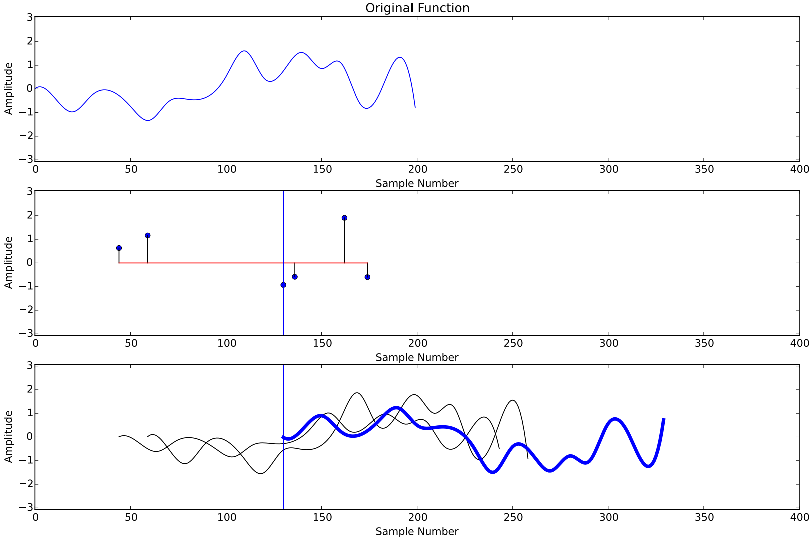
Convolution

- ▷ Add overlapping signals, *delayed* and *decayed*



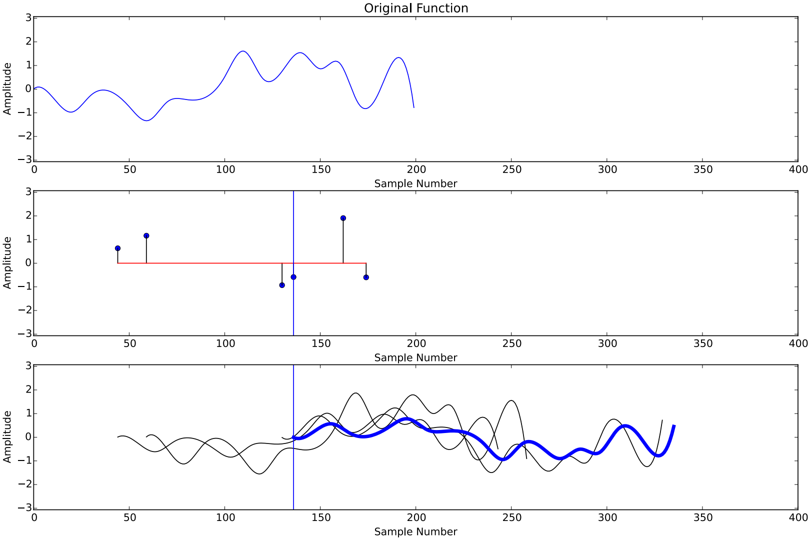
Convolution

- Add overlapping signals, *delayed* and *decayed*



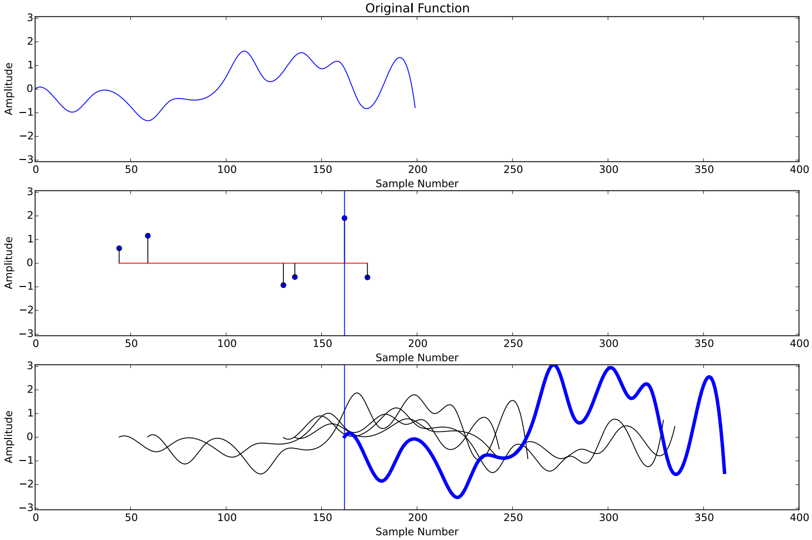
Convolution

- Add overlapping signals, *delayed* and *decayed*



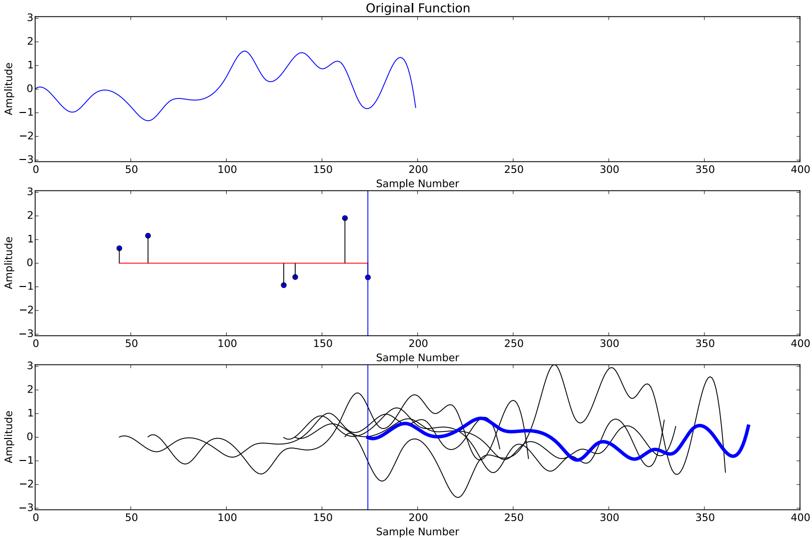
Convolution

- ▷ Add overlapping signals, *delayed* and *decayed*



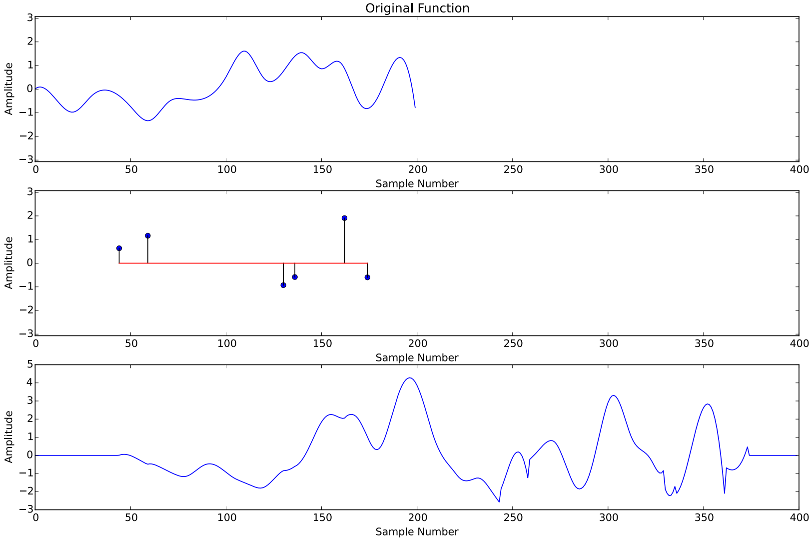
Convolution

▷ Add overlapping signals, *delayed* and *decayed*



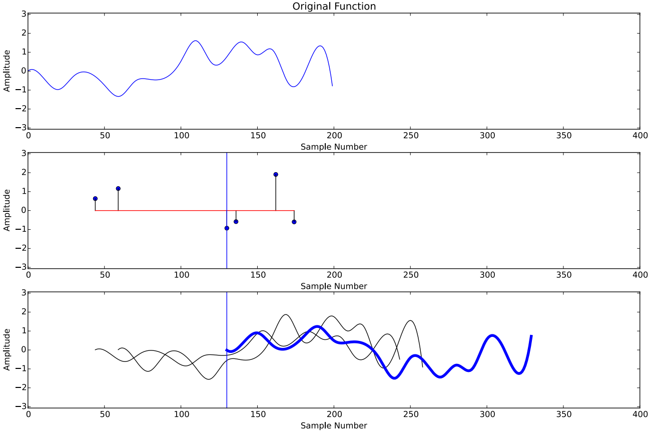
Convolution: Result

- Add overlapping signals, *delayed* and *decayed*



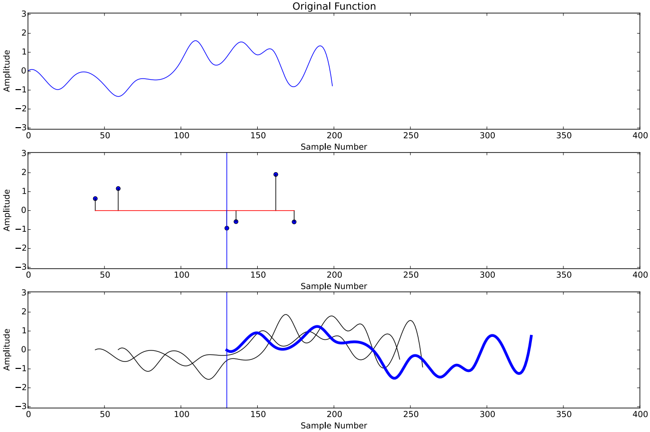
Convolution: Notation / Equation

$x[n]$: Discretely sampled signal describing the sound
$h[n]$: Discretely sampled signal describing impulse



Convolution: Notation / Equation (RAFFLE POINT)

$x[n]$: Discretely sampled signal describing the sound
$h[n]$: Discretely sampled signal describing impulse



Convolution: Notation/Equation

$x[n]$: Discretely sampled signal describing the sound
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$$(x * h)[n] = \sum_{k=0}^{N} h[k]x[n-k]$$

Convolution: Notation/Equation

$x[n]$: Discretely sampled signal describing the sound
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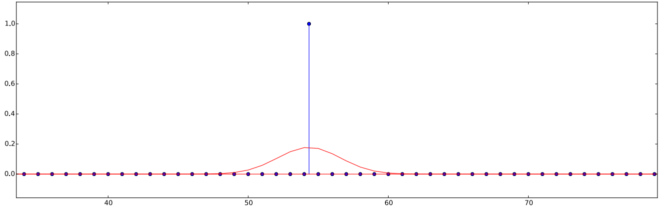
$$(x * h)[n] = \sum_{k=0}^{N} h[k]x[n-k]$$

Roles can switch!

Gaussian Interpolation

Given non-integer bin index n_0 with amplitude a

$$h[n] = ae^{-(n-n_0)^2/2\sigma^2} / \left(\sum_{k=-2\sigma}^{k=2\sigma} e^{-(n-n_0)^2/2\sigma^2} \right)$$



Convolution Examples

Interactive demo

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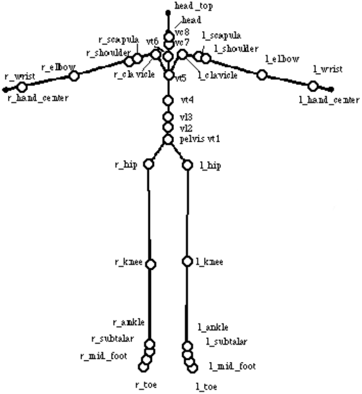
Scene Graph: Human body



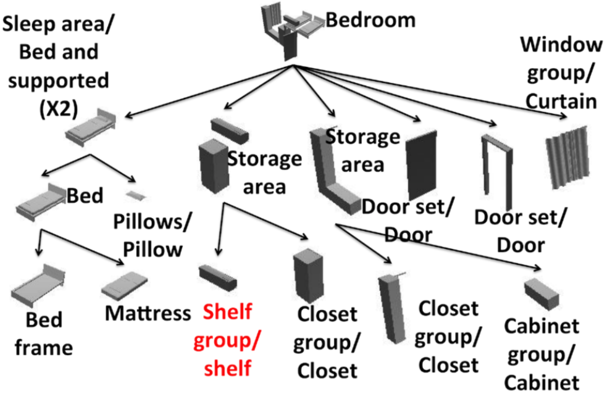

```
HumanoidRoot : sacrum
  sacroiliac : pelvis
  |    l_hip : l_thigh
  |      l_knee : l_calf
  |        l_ankle : l_hindfoot
  |          l_subtalar : l_midproximal
  |            l_midtarsal : l_middistal
  |              l_metatarsal : l_forefoot
  |    r_hip : r_thigh
  |      r_knee : r_calf
  |        r_ankle : r_hindfoot
  |          r_subtalar :  r_midproximal
  |            r_midtarsal : r_middistal
  |              r_metatarsal : r_forefoot
  vl5  : l5
    vl4 : l4
      vl3  : l3
        vl2 : l2
          vl1  : l1
            vt12 : t12
```

Figure courtesy of `http://www.euclideanspace.com/physics/kinematics/joints/`

Scene Graph: Human body

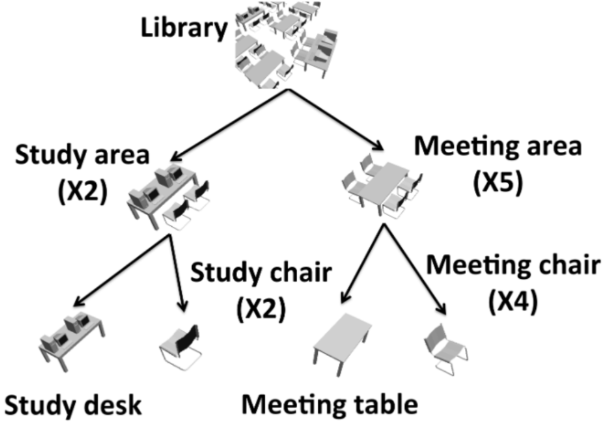
MOCAP interactive example

Scene Graph: Bedroom



Liu, Tianqiang, et al. "Creating consistent scene graphs using a probabilistic grammar." ACM Transactions on Graphics (TOG) 33.6 (2014): 211.

Scene Graph: Library



Liu, Tianqiang, et al. "Creating consistent scene graphs using a probabilistic grammar." ACM Transactions on Graphics (TOG) 33.6 (2014): 211.

Scene Graph: Euler Angles Visualization

Designing Scene Graphs

Interactive Example